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Freshwater and Anadromous Division
Maritimes Region

Design of Fish Passage Facilities for Nepisigüit Falls, New Brunswick

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ABSTRACT

This paper describes the functional design of a pool and weir fishway having 54 pools and the accessories required to enable Atlantic salmon to ascend a head difference of 33.44 meters (109.7 feet). The facilities are proposed for a site on the Nepisiguit River near the City of Bathurst in the northeast corner of New Brunswick. Nepisiguit River encompasses the fourth largest drainage area in the province. It is estimated that up to 25,000 Atlantic salmon can be produced from this system annually.

In addition to describing the major features of the fishway design itself and how it fits into the site, the author also provides details of the functional aspects of the fish trapping facilities and design of the biological evaluation building associated with Pool 51 near the top end of the fishway.

INTRODUCTION

For many years staff from the Department of Fisheries and Oceans, Resource Branch, located in Halifax have been studying all of the major rivers in the Maritime Provinces for the purpose of Atlantic salmon enhancement in the Region. One of the most promising sites to be identified has been the Nepisiguit River which flows into Chaleur Bay. Eighty percent of this system has always been inaccessible to anadromous fish because of a natural waterfalls 29 kilometers (18 miles) upstream from the head of tide. In 1919, construction of a concrete dam and power station was completed by Consolidated Bathurst Pulp and Paper Company around the top rim of the very rugged natural falls, cut out of the volcanic rock formation at this location in the river. The electrical energy produced from these turbines has been used for the manufacture of pulp and paper in the plant at Bathurst. The company name was changed in 1979 to Consolidated-Bathurst Incorporated.

After considering the various alternatives (described briefly elsewhere in this paper) for passing fish upstream of this major barrier, it was decided to proceed with the design of a conventional pool and weir type fishway.

NEPISIGUIT RIVER SYSTEM

Nepisiguit River originates in north-central New Brunswick in Restigouche County and flows in an easterly direction through Northumberland County and north-easterly through Gloucester County. The total meander length is 140 km (87 miles), it empties into Nepisiguit Bay on the south shore of the Bay of Chaleur. The river has a drainage basin of 2330 km^2 (900 sq.mi.) which is the fourth largest watershed in New Brunswick (see Figure 1). Lakes in the headwaters are small and few in number, the river descends on a moderately steep gradient averaging about 7.3 meters (24 feet) per mile. This gradient is quite uniform and regular except for a few rough sections in the lower 30 km of the main stem which contains a couple of sets of rapids and a small falls. Except for the main falls proposed for development of fish passage facilities, no other major barriers to salmon migration have been identified on the system.

Most of the territory through which the river flows is heavily forested with hardwood and coniferous trees. Much of the top end of the system is quite inaccessible to the general public. A relatively small amount of residential and commercial development exists in the lower reaches of the system. Mining and pulp and paper industries have existed in the area since the early 1900's. The water quality does not appear to have been harmed by activities in the watershed area, except for a couple of localized discharges from mining sites which has been largely brought under control. Heavy metals, such as iron, lead, zinc and silver, have been mined in limited amounts near streams in the lower third of the watershed. A couple of mines are still active in the area.

DRAINAGE AREA MAP AND

SITE LOCATION PLAN

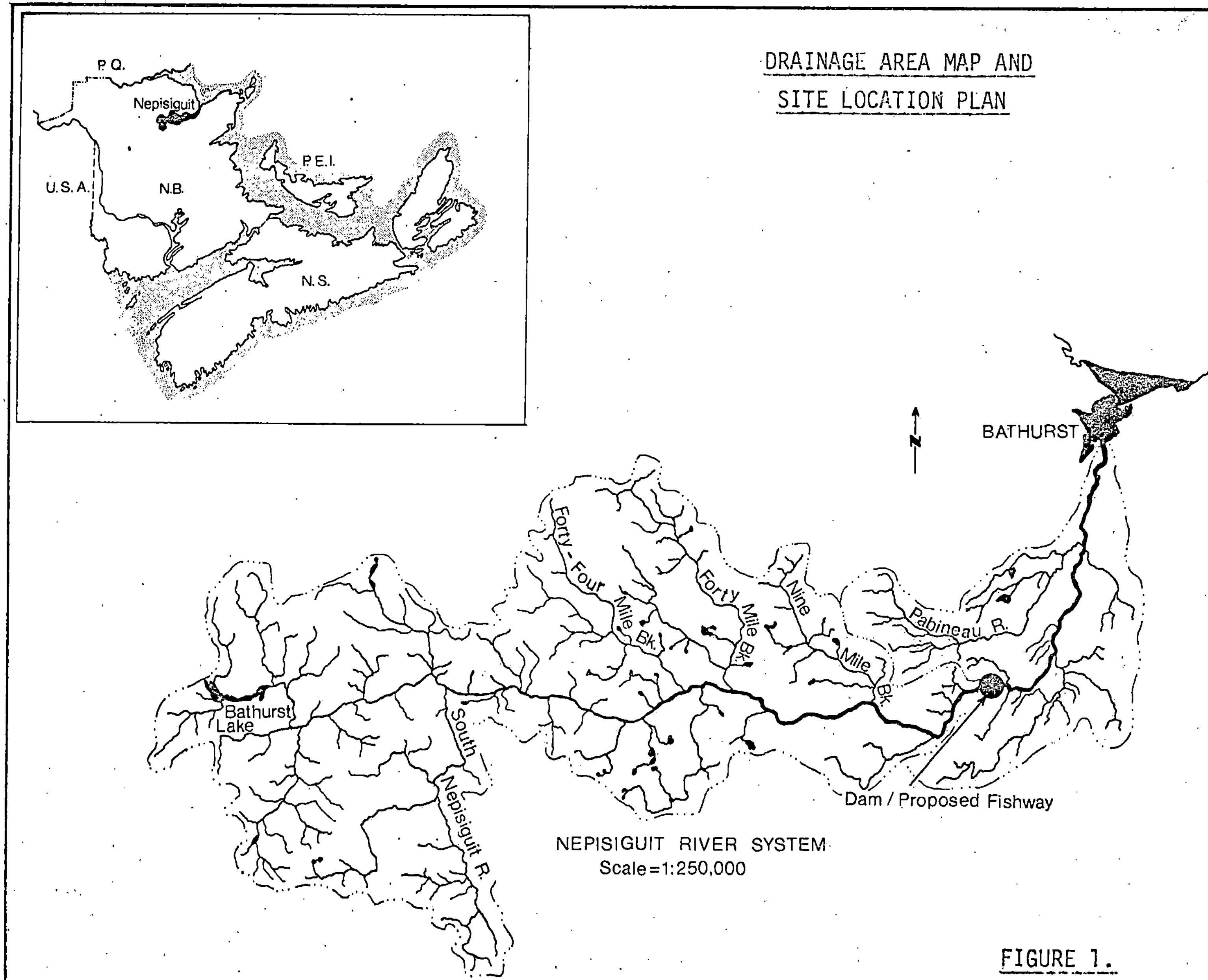


FIGURE 1.

POWER STATION AND SITE

A power station dam was completed about 1919 around the top rim of the natural falls on Nepisiguit River 33.5 kilometers (21 miles) upstream from the mouth of the river. The site is located 30 kilometers (18.5 miles) by road from the city of Bathurst (see Figure 1). The power station was built for the purpose of supplying electrical energy to the Consolidated Bathurst Limited (as of 1979, Consolidated Bathurst Incorporated) pulp and paper plant at Bathurst.

Two generators were originally installed with a third unit added at the north end of the station about ten years later. Each of the three units is rated at 3600 KVA. Any excess power is supplied to the New Brunswick Electric Power Commission for general distribution. All three units are operating in the spring and fall, during the summer there is only sufficient water to operate one or two generators. When the turbines are operating at full capacity the total flow passing through the power station is 45.3 m^3/sec (1600 cfs), each turbine has a total capacity of about 15.0 m^3/sec (530 cfs).

The Nepisiguit River at the site flows approximately west to east through a narrow rock gorge, approximately 25 meters wide and 26 meters deep. Just above the main pool where the power station discharges, there is a natural falls some 24 meters in height, at the top of which is constructed a concrete gravity dam approximately 12 meters high. The power house is located on the true left bank (facing downstream) of the river at the base of the falls. The falls itself consists of approximately a 5 meter vertical drop at the base, above which is a pool some 55 meters in length in a very narrow rock gorge. Above this pool the falls rises on a slope of about one vertical to two horizontal to the base of the dam.

Nepisiguit Falls is located at the northern end of the Miramichi Highlands, an 80 kilometer wide belt of strongly folded sedimentary and volcanic rocks intruded by granite, which trends north-north eastwards through the centre of the Province. At the Falls, the bedrock is a greenish grey Augen schist. It is a strong crystalline rock of volcanic origin and is of Middle Ordovician age, belonging to the Tetagouche Group. Just upstream of the existing dam and 500 meters or so downstream of it, the rock type changes from schist to sedimentary greywache and slates but the entire fish passage facilities would be constructed in the Augen schist rock formation.

HYDROLOGY

Nepisiguit River has a total drainage area of 2330 km^2 (900 sq.mi.). The drainage area above the Grand Falls power station is 1844 km^2 (712 sq.mi.). River flows at the power station have been measured by a gauging station since 1924, for the fifty years of records at our disposal average monthly flows were determined as follows (data expressed in m^3/s):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min.	11.6	9.1	8.1	14.8	63.7	28.9	16.4	10.6	10.2	13.0	16.5	13.1
Mean	16.2	12.2	12.5	52.9	133.9	53.4	27.3	18.7	17.2	23.1	31.3	24.1
Max.	24.8	23.5	24.5	149.8	237.7	99.6	49.5	38.7	37.8	49.8	63.9	48.2

These flows give us an indication of the variability of runoff by month, as well as the normal range of extremes to be expected.

Flood flows for three return frequencies were estimated by ADI Limited and related to tailrace elevations, the data is as follows:

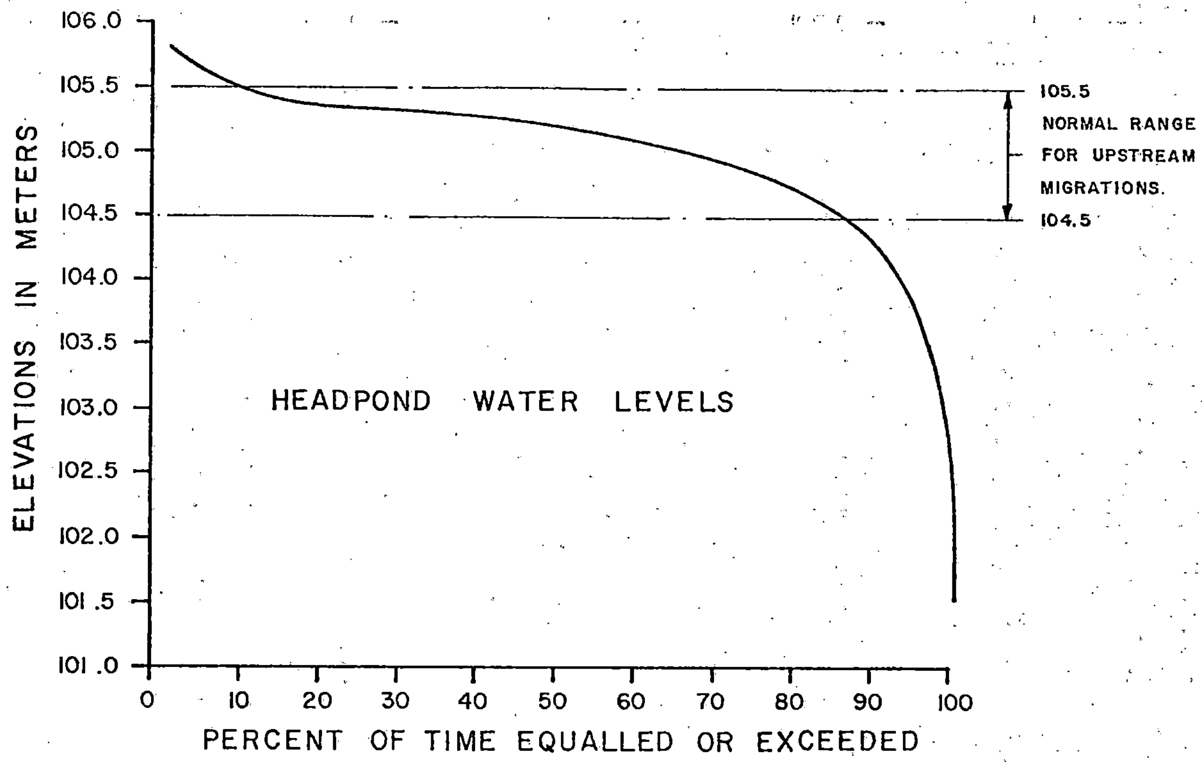
Return Frequency	Range of Flood Flows (m^3/s)	Expected Tailrace Elevations (in meters)
1: 2 yr.	255 - 315	76.5
1: 20 yr.	455 - 650	79
1:200 yr.	595 - 880	81

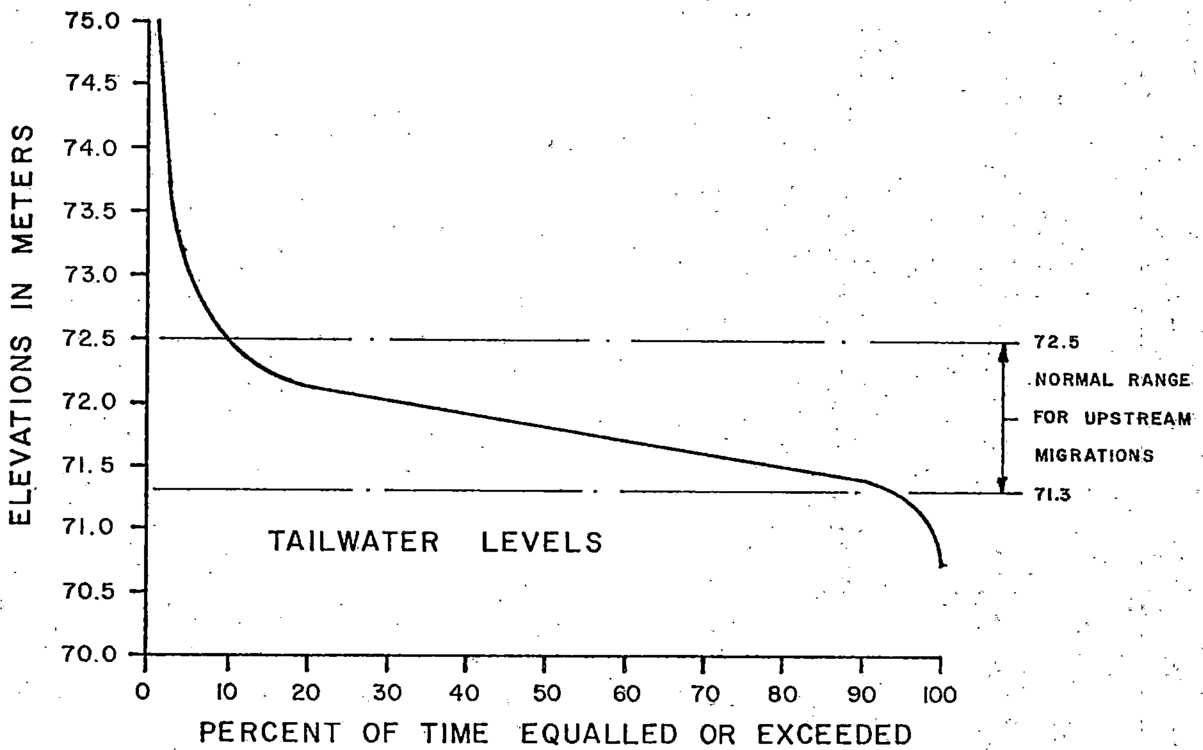
Low flow probabilities for the river at Grand Falls are as tabulated below (this is also from ADI Limited data):

Recurrence Interval	Duration (days)	Flow m^3/s	Estimated Tailrace Elevations (m)
25 yr.	1	3.2	71.0
100 yr.	1	2.5	71.0
100 yr.	7	4.1	71.1
100 yr.	30	4.6	71.14

During the upstream fish migration season (i.e., June - November), the head pond is expected to fluctuate between 104.5 and 105.5 meters at the fishway exit, and the tailrace is expected to fluctuate between 71.3 and 72.5 meters at the fishway entrance. The normal elevations for upstream fish passage being 105.22 and 71.78 meters respectively.

Figure 2 shows the percent of time equalled or exceeded for any given water levels in the headpond or tailrace. These curves are based on recorded data between June 1 and November 30 for the period 1960-69 inclusive, this being the most reliable information available.





NEPISIGUIT RIVER AT GRAND FALLS
FOR PERIOD OF JUNE 1 – NOVEMBER 30
FROM RECORDS 1960-1969 INCLUSIVE

FIGURE 2

FISHERIES POTENTIAL

Nepisiguit River is probably the most promising river in the Maritime Provinces for salmon enhancement due to its large size, relatively good water quality and exceptionally good spawning and rearing areas. At present, about 80% of the system is inaccessible to anadromous fish because of the barrier at Grand Falls. There are very few lakes of any significant size on this watershed, therefore the potential for alewives is small. The major effort for enhancement of the fisheries resource on this system is directed toward Atlantic salmon. This does not preclude expansion of other species of anadromous fish such as sea run trout and alewives.

A survey done by G. Turner in 1969 showed the total stream length to be 378 km (230.6 mi), the spawning and rearing areas for salmon being: 1,068,622 m^2 and 9,753,524 m^2 respectively.

The total production potential of Nepisiguit River above the obstruction is 25,000 adult salmon. The harvestable production potential of the system is setimated at 20,500 adult fish, with a spawning escapement requirement of 4,500 fish. It is projected that 17,500 adults (7,100 grilse and 10,400 2-sea-winter salmon) will be available for harvest in the Maritime fishery. In addition, it is projected that 4,500 adults (3,000 1-sea-winter and 1,500 2-sea-winter) could be harvested in the Newfoundland fishery. Should they not be harvested in the Newfoundland fishery, roughly the same weight of fish would then be available for harvest in Maritime fisheries.

The main cultured stage to be utilized in the project would be fall fingerlings, although it is assumed a few smolts (10,000) would be released annually into this system. Assuming that fisheries can be maintained during the enhancement phase at 50% of that which the system should be able to support once it is producing at full production, it is projected that 70,000 smolts and 7.0 million hatchery-reared fall fingerlings will be required to fully colonize the system. The fingerlings stocks would be seeded over a 7-year period. The fingerling salmon and smolts would be produced at Charlo and Miramichi hatcheries in Northeastern New Brunswick.

Timing of the Migrations

The adult salmon begin their upstream migration at this location in July and a late run extends into October. Two peaks would be expected to occur at the new fishway about late July and again in early October.

Downstream migrations would be expected to commence in April and extend through June. Kelts returning to sea would lead the way and complete their descent by late May, smolt would move out between early May and the end of June.

Cost Benefits

A detailed costs benefit analysis has not been completed. However, preliminary estimates have been quite favourable for development of the salmon potential of Nepisiguit River. The estimated potential harvest per year could reach 20,500 fish when the system is fully developed. Using an average weight of 3.17 kilograms (7 pounds) per salmon, this would yield a total weight of 64,990 kilograms (143,500 pounds).

PROPOSED UPSTREAM FISH PASSAGE FACILITIES

Rationale for Selection and Location of Fishway

During the past ten or so years, the Resource Branch has considered a number of alternatives for further developing the salmon potential of Nepisiguit River. For example, the feasibility of establishing a trucking and trapping facility at one of four possible locations, namely: Grand Falls (the power station site), Pabineau Falls, Chain Rock Rapids and Middle Landing Rapids have been considered. Comparable capital cost estimates were determined for construction of trapping and trucking or trapping and hoisting at Grand Falls or trapping and trucking further downstream. Downstream sites have the additional problem of separation of stocks destined for the areas above and below the obstruction. Also, construction of a barrier dam would result in further delays for fish and increase the opportunity for poaching and cause flooding of private lands.

More recently, two final alternatives were examined and approved, for a final feasibility study. They were: trapping and trucking or trapping and hoisting at Grand Falls, versus a conventional fishway at this location. Finally, when considering the long term requirements for high maintenance and high operating costs for a trucking and trapping facility, it was decided to proceed with the design of a conventional fishway at the power station site. The conventional fishway alternative has basically no operating cost and no manpower requirements. In addition, this type of facility is extremely reliable because it is not subject to mechanical or electrical breakdown. See Figure 3 for overall layout.

Positioning of the fishway entrance is one of the most important considerations in designing any upstream fish passage facility and is normally the starting point in determining the most desirable route for

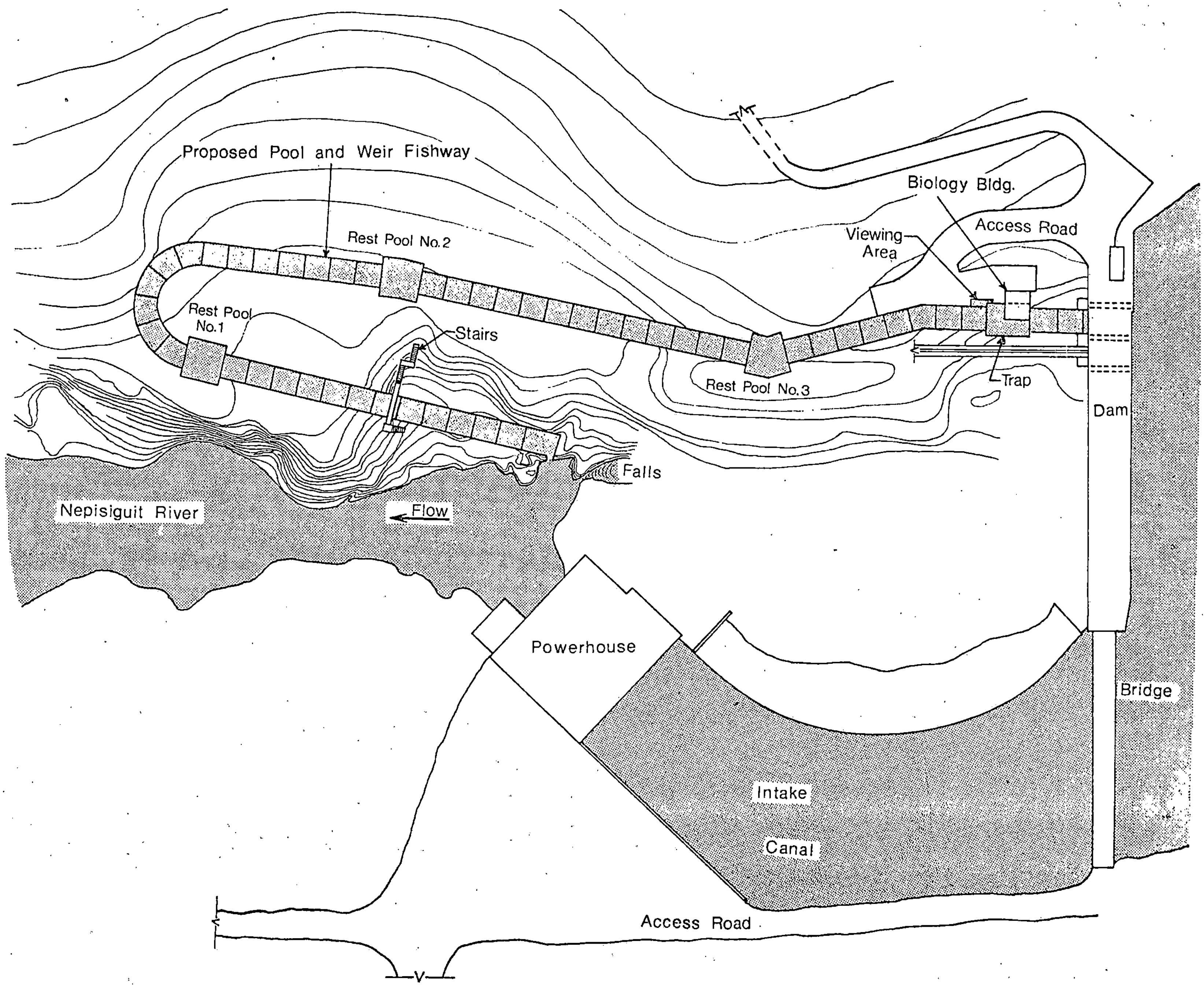

Proposed Pool and Weir Fishway
Rest Pool No.2
Biology Bldg.
Access Road
Viewing Area
Rest Pool No.1
Stairs
Rest Pool No.3
Trap
Dam
Falls
Nepisiguit River
Flow
Powerhouse
Bridge
Intake
Canal
Access Road

FIGURE 3.

the fishway. Observations of salmon reaching Grand Falls just below the power station over the years, strongly indicate that fish normally hold up along a rock ledge outside of the power station canal and just below a 5 meter falls on the former main flowage of the river. Continuous leakage through the dam provides a good attraction flow to the uppermost point in the tailrace pool. The shoreline on the true right bank of the river (across from the power station discharge) is nicely indented so as to provide a protected entrance for a fishway. The identation of this shoreline would allow a fishway entrance to be set back clear of the major portion of the high spring flows cascading through the narrow gorge. Also, during normal water conditions flow from the fishway would be quite pronounced coming from this relatively quiet small bay area. Two other factors which support placing the fishway on the shoreline opposite the power station side of the river are: there would be less rock excavation, and with extensive blasting required the extra distance from the power station and the dam itself minimize the possibility of damage to existing structures at the site.

The most economical and practical route for the remainder of the fishway and its exit into the headpond was selected. The fishway will exit through the last span of the bridge and stoplog section which is 4.9 meters wide and is not required for release of flood flows.

The site is covered with a medium dense forest of relatively low growth due to the limited amount of topsoil and overburden available. Along the lower portion of the fishway rock outcrop is very evident, and along the top half there is between 1.5 and 3 meters of overburden.

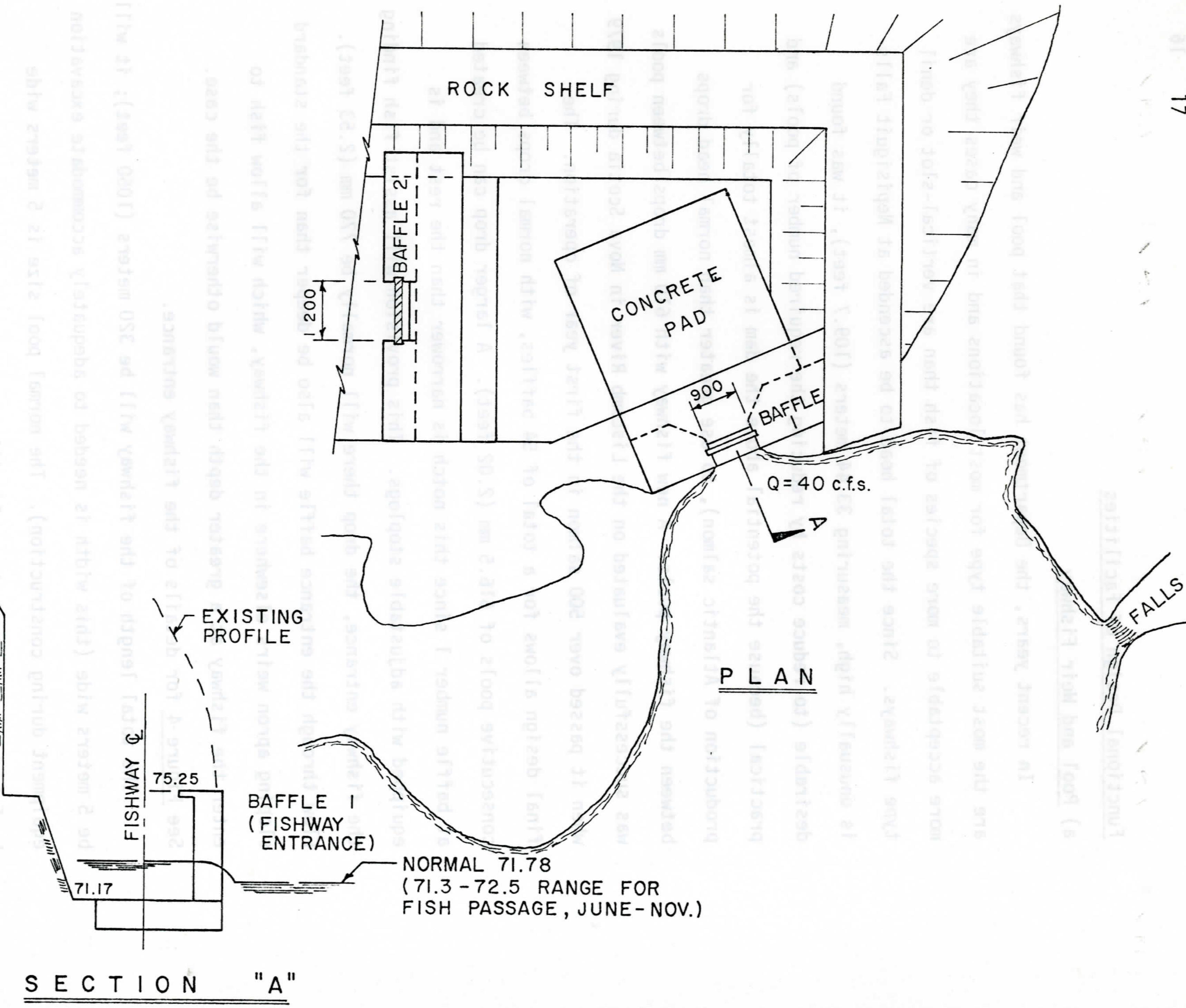
One factor which could affect the proposed fisheries development project on Nepisiguit River is a feasibility study initiated recently by owners of the Grand Falls Power Station for further hydroelectric power generation on the river.

Functional Design of Facilities

a) Pool and Weir Fishway

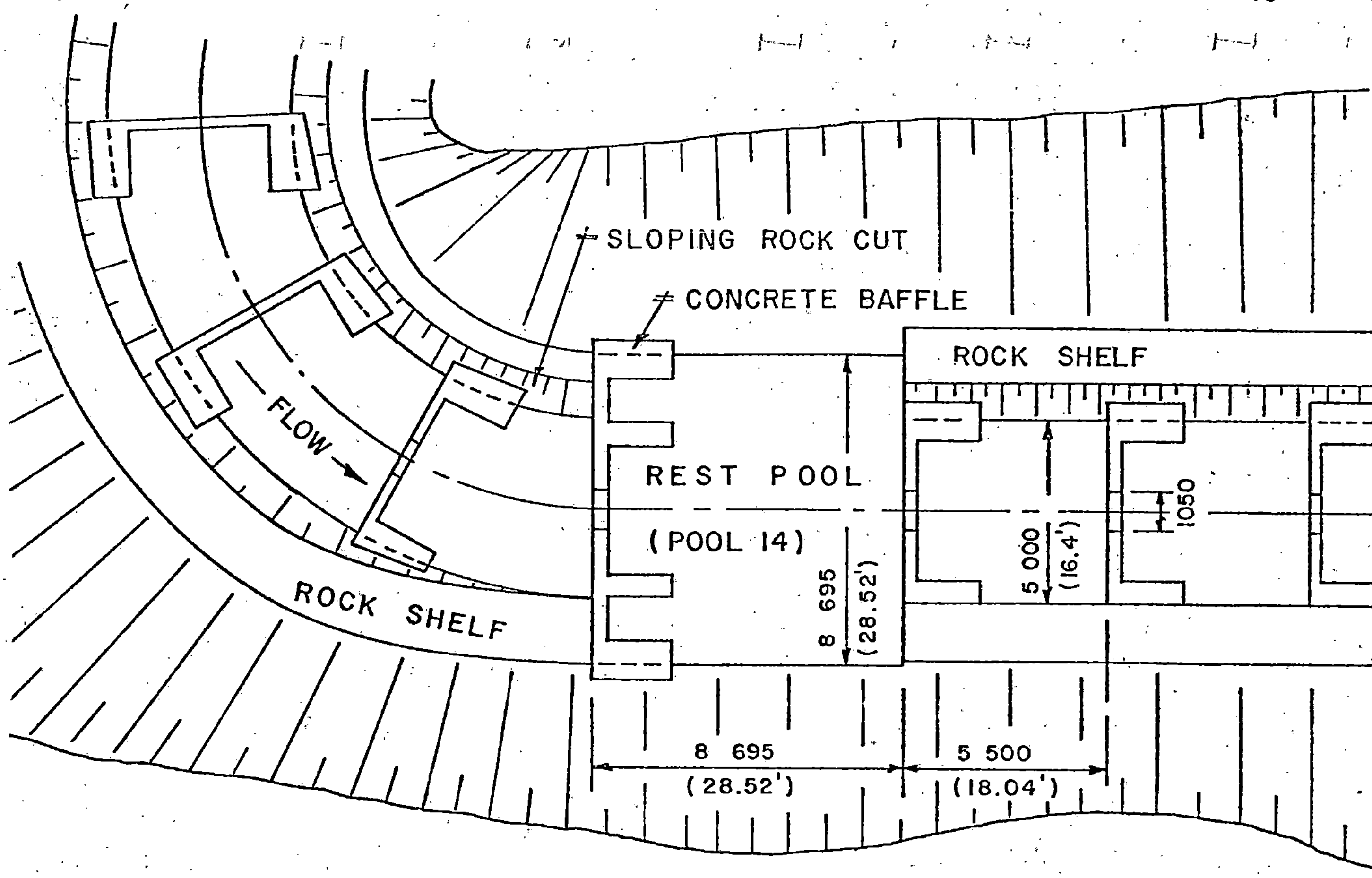
In recent years, the Department has found that pool and weir fishways are the most suitable type for most locations and in many cases they are more acceptable to more species of fish than are vertical-slot or denil type fishways. Since the total head to be ascended at Nepisiguit Falls is unusually high, measuring 33.44 meters (109.7 feet), it was found desirable (to reduce costs by reducing the required number of pools) and practical (because the potential above the dam is almost totally for production of Atlantic salmon), to use greater than normal head drops between the fishway pools. A new fishway with 610 mm drops between pools was successfully evaluated on the Liscomb River in Nova Scotia during 1979 when it passed over 500 salmon in the first year of operation. The final design allows for a total of 54 baffles, with normal drops between consecutive pools of 616.5 mm (2.02 feet). A larger drop can be created at baffle number 1 since this notch is narrower than the rest and is equipped with adjustable stoplogs. This provision will assist fish finding the fishway entrance, the drop there will normally be 770 mm (2.53 feet). Flow through the entrance baffle will also be deeper than for the standard sloping apron weirs elsewhere in the fishway, which will allow fish to enter the fishway at a greater depth than would otherwise be the case. See Figure 4 for details of the fishway entrance.

The total length of the fishway will be 320 meters (1050 feet); it will be 5 meters wide (this width is needed to adequately accommodate excavation equipment during construction). The normal pool size is 5 meters wide by 5.5 meters long and the pools will have an average water depth of 1.37 meters. Three rest pools have been provided at a spacing of every 14th pool, they are approximately square measuring about 8.695 meters



FISHWAY ENTRANCE DETAILS

FIGURE 4



DETAILS OF TYPICAL POOL CONFIGURATION

FIGURE 5

per side. These larger pools, in addition tl providing good rest areas for ascending fish, will also provide much needed turning space for construction equipment. See Figure 5 for pool sizes and associated details.

The fishway was designed to operate on a normal flow of 1.132 m^3/sec (40 cfs). It was felt that the fishway should pass a flow at least equal to the leakage flow passing over the adjacent small falls to which they are naturally attracted. Also, since this is a very large fishway required to pass a large run of salmon, it was decided that the flow should be two or three times that for normal fishways in the Region.

The kinetic energy generated by the design flow in dropping from pool to pool can be calculated as follows:

$$K.E. = \frac{Q\ w\ h}{550} \quad \text{expressed in horsepower}$$

where $Q = 40$ cfs

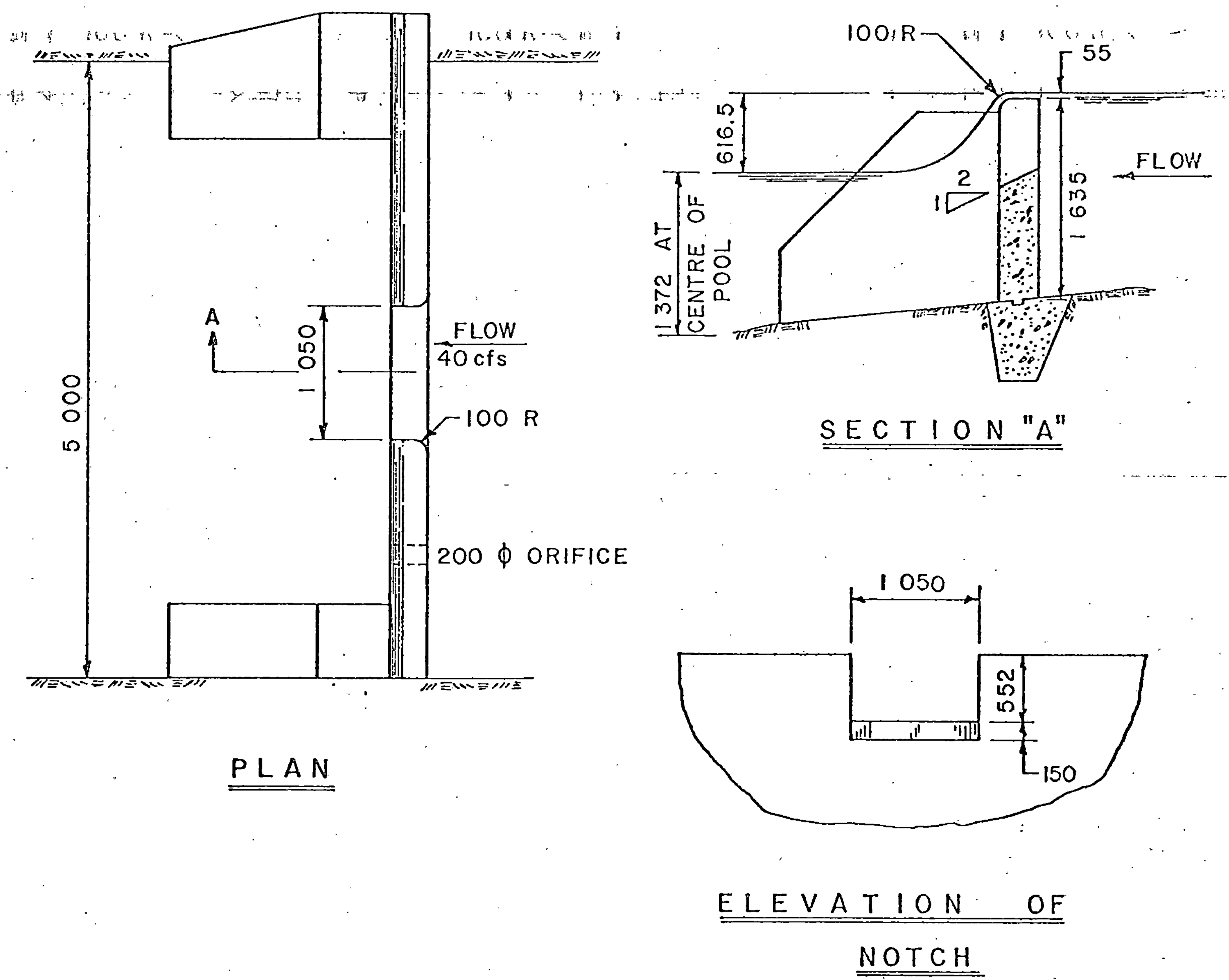
$w = 62.4$ lb/cu.ft.

$h = 2.02$ feet

$$= \frac{40\ (62.4)\ 2.02}{550} = 9.17 \text{ h.p.}$$

For pool and weir fishways, the Department has found that a minimum of 125 cu.ft. of water volume is required per horsepower of kinetic energy generated to adequately absorb the energy and to control excessive turbulence within each pool, so that there is no carry-over of velocity or turbulence to pools below. Using this criterion the required pool volume for this fishway is 9.17 x 125 = 1146.25 cu.ft. The net pool volume in fact is 1256 cu.ft., which provides a small safety factor.

Three different notch widths occur throughout the fishway for passing the design flow of 1.132 m^3/s. In the four top baffles not all the flow is passed through the notches which are stoplogged to the floor. By removal of stoplogs in these baffles, the fishway can be operated at headpond levels 2.5 meters below normal, which is required occasionally for power station maintenance purposes. These notches are 1.2 meters wide. This is the case also for baffle #2 at the lower end of the fishway. The remaining baffles, except for baffle #1, spill full width but the major portion of the flow is via the notches. These notches are 1.05 meters wide and they have sloping aprons just across the thickness of the baffles. The overspill depth across the full width of these baffles will be 55 mm. See Figure 6 for typical baffle and notch sizes.



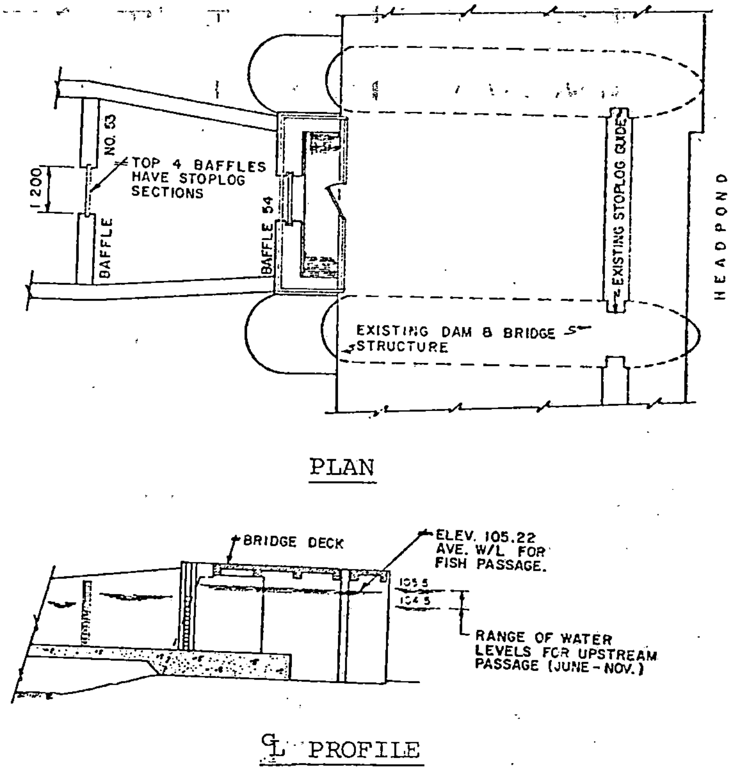
TYPICAL BAFFLE DETAILS

FIGURE 6.

The entrance baffle is narrower (i.e., 900 mm) than the remaining baffles in order to create extra head and to increase the velocity of outflow at the entrance for the purpose of more readily attracting the fish into the fishway should these provisions be needed. In addition to flow in the notches and the overspill for 48 of the 54 baffles, a small amount of the 1.132 m^3/s will pass through a 200 mm diameter orifice at the floor of all but the top baffle. This flow has been calculated to be about

0.066 m^3/s (2.3 cfs).

Flow through the fishway will be regulated by a set of timber stoplogs in the top baffle (See Figure 7 for details at the top end of the fishway).



DETAILS OF FISHWAY EXIT AND FLOW CONTROL

FIGURE 7

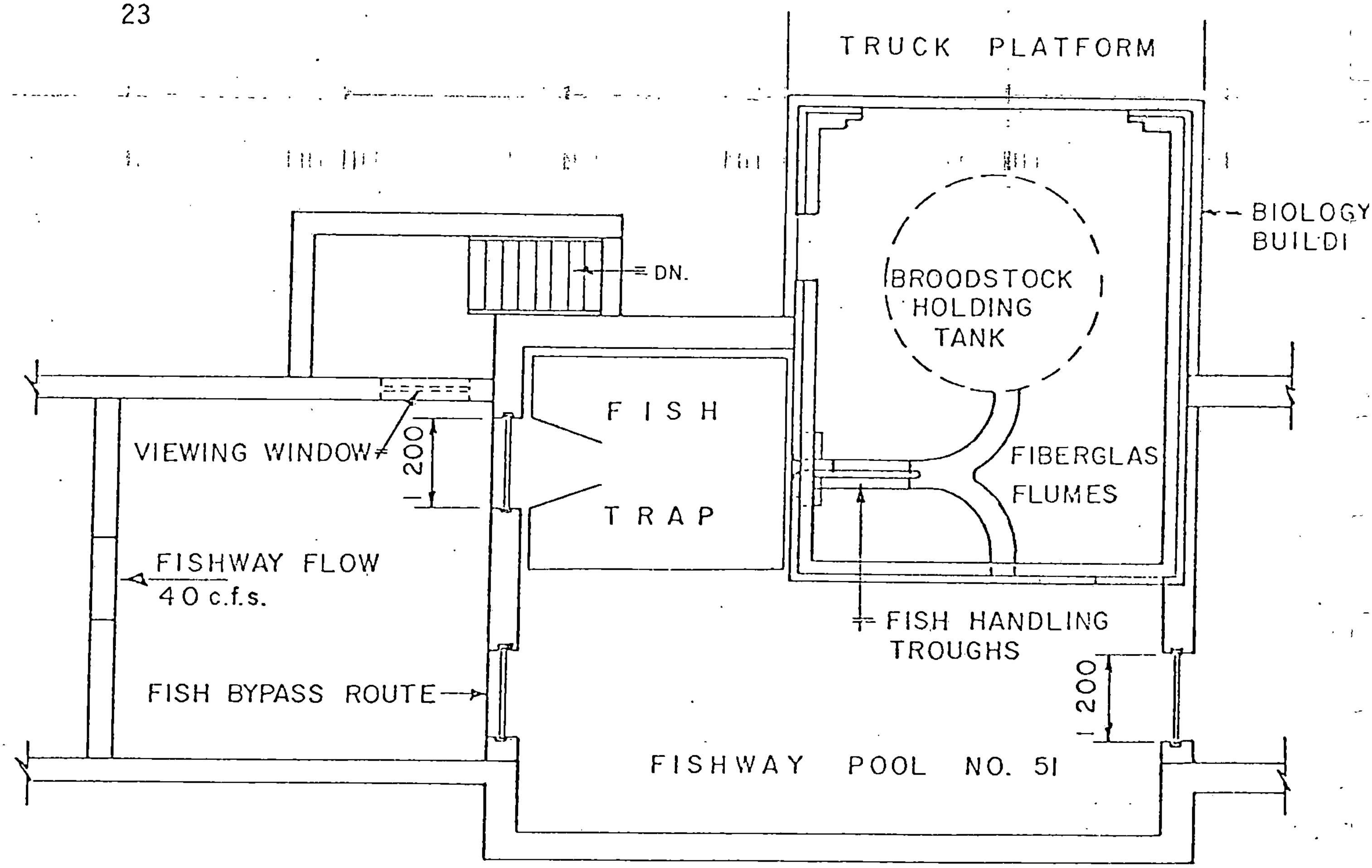
It is significant to note some of the structural features of the rock which forms the floor and side walls of the fishway for most of its length. At the bottom of the excavation a channel 5 meters wide by 4 meters deep will be prepared for installation of concrete baffles. The side slopes of the rock excavation vary depending on the joint sets and strike or dip of the formations. The side slopes on the fishway channel are vertical on one face and at a slope of 1 horizontal to 4 vertical on the other face generally. Then along both sides of the fishway the rock is benched horizontally 1.5 meters in most areas. This is for access purposes for cleaning out and maintaining fishway pools as well as to provide a ledge to catch falling rock after construction is completed. From these ledges, the rock cut is on a slope of 1 to 4 on one side and 1 to 1.6 on the other side generally to the rock surface or to the overburden. Rock slopes will be reinforced by installation of rock bolts at a spacing of about 2.25 meters as determined as excavation proceeds downward.

b) <u>Fish Trap and Biology Building with Fish Handling Facilities</u>

A trap to be made from steel grating will be located in pool number 51. This pool has been enlarged to accommodate the 3.5 m long by 3.0 m wide trap, plus a significant portion of the biology building. Fish can be bypassed around the trap and the elevation area by way of a second weir in baffle 51. The other weir will be used to bring fish into the trap. This weir is located quite close to the fishway wall and just downstream of the baffle where fish are expected to gather before entering the trap. As a public attraction, it was decided to provide a window in the sidewall of the fishway at this location. The trap will be operated by an overhead electric hoist. The entrance funnel is 1.05 m long and it tapers from a width of 1.28 m to a clear opening of 0.22 m on the upstream end. The floor of the trap is sloping to the upstream end, it also slopes from sides in towards the center. These features were designed to provide a simple yet positive method for getting fish out of the trap and into the handling facility.

A building 5.5 m by 6.6 m will house the fish handling and evaluation activities. Fish enter the building in a stream of water .03 m^3/s (1 cfs) fed through a fiberglass flume from the trapping area. The water supply is fed into the building by gravity from an upper pool in the fishway. There the fish are evaluated and sorted. Fish then exit into either a round holding tank for collecting broodstock or they are returned to the fishway for escapement to the headwaters of the river. Water enters the broodstock holding tank via a water chiller which is to maintain the temperature of incoming water at or below 15°C (60°F).

Details of facilities described briefly above are shown in <u>Figure 8</u>.



FISH TRAP AND BIOLOGY BUILDING

FIGURE 8

DOWNSTREAM FISH PASSAGE CONSIDERATIONS

Upstream fish passage facilities can be rendered ineffective if care is not taken to ensure the safe downstream escapement of juvenile and spent adult fish. At Nepisiguit Falls, studies are being conducted to determine the mortality rate for smolt passing through the turbines, over various selected portions of the spillway, and through the flood control gates. These studies will also indicate the preferred routes and possible collection points in the headpond for fish moving seaward during spring and early summer. The smolts are the result of fry and fingerlings which were stocked over the past few years, as well as hatchery smolts released for test purposes.

Experiments will be conducted by Branch staff during the spring of 1980 in an effort to develop suitable downstream fish passage facilities. Work will consist of:

a) Simulating conditions at the top end of the proposed fishway to determine if smolt will in fact choose to use the upstream fish passage route on their seaward journey.

b) Develop a surface outlet at the existing stop-logged opening adjacent to the turbine intake screens. This opening has been used in the past for passing logs and debris which collect along the bar screens at the most downstream location in the power canal.

Both of the above experimental facilities will be equipped with overflow type weirs and fish traps. The monitoring program will try to determine the movement patterns of semi-wild smolt and their natural choice of routing as they approach the power station. Sonic tagging will also be used as a further aid in monitoring downstream migrants past the power station site.

The stock which will be available during the spring of 1980 are the result of stocking 168,000 hatchery reared fall fingerlings in the headwaters in 1978, plus the planned release in the early spring of 1980 of about 10,000 hatchery smolt above the power station.

PLANNED PROGRAM

The Department is currently in the planning stage of a major Atlantic Salmon Enhancement Program for the Maritime Provinces. We expect that planning for the program can be completed by the end of 1980/81 fiscal year. The Nepisiguit Grand Falls fishway with an estimated cost of 1.5 million dollars is one of the components of the overall enhancement program.

The decision to proceed with construction of upstream fish passage facilities hinges on three factors:

(1) The magnitude of the downstream fish passage problem which is being investigated by biological staff, and the associated costs for facilities that may be required.

(2) The further development of the river's hydro potential, the feasibility of which is currently being investigated by consultants for Consolidated Bathurst Incorporated.

(3) Finalization of the socio-economic analysis of the potential of the river.

An appropriate stocking program will be developed when needed and the timing coordinated with the resolution of the factors referred to above, which must preceed actual construction.

Tables 1 and 2 at the end of this paper provide a "List of Quantities" and a "Construction Schedule" for use in tendering and to assist with phasing of construction.

ACKNOWLEDGEMENTS

The direct assistance of the following people in the Freshwater and Anadromous Division of the Resource Branch of the Department was greatly appreciated in the preparation of this paper. Head of Engineering Services, H. Jansen; technicians - P. Gallop and C. Pellerin; drafting and illustrations - B. Kent, N. Whynot and J. Close; typing - B. Schofield. In addition to those who provided direct assistance, information provided in biological reports prepared over the years by members of the Stock Assessment and Enhancement Section was very helpful.

A.D.I. Limited of Fredericton, New Brunswick, provided the structural design drawings and much of the feasibility studies information. The work of D. DeMerchant from that Firm is noteworthy.

NEPISIGUIT FALLS FISH PASSAGE FACILITIES

"List of Quantities"

Item No.	Description	Unit	Quantity
1	Clear & Grubb	Ha	1
2	Common Excavation	m^3	7,877
3	Solid Rock Excavation	m^3	45,757
4	Demolition of Existing Structures	L.S.	L.S.
5	Dewatering	L.S.	L.S.
6	Borrow		
	Subbase	m^3	120
	Base	m^3	75
	Perforated drain	m^3	10
	Pipe	m^3	100
	Wall	m^3	100
7	Reinforcing Steel	Kg	56,100
8	Cast in Place Concrete	m^3	1,349
9	Rock Bolts		
	25 mm x 6000	ea	37
	25 mm x 4500	ea	29
	25 mm x 4500 + ext	ea	6
	25 mm x 3500 + ext	ea	2
	35 mm x 7500 + ext	ea	5
10	Drainage Piping		
	600 Ø	m^3	36
	150 Ø	m^3	53
11	Miscellaneous Metals	L.S.	L.S.
12	Stoplogs	m^3	2.6
13	Biology Building	L.S.	L.S.
14	Access Bridge	L.S.	L.S.
15	Mechanical	L.S.	L.S.
16	Equipment	L.S.	L.S.
17	Electrical	L.S.	L.S.
18	Asphaltic Concrete	m^2	485

TABLE 1.

NEPISIGUIT FALLS
FISH PASSAGE FACILITIES
"CONSTRUCTION SCHEDULE"
TIME IN MONTHS

Item	Phases I	Phases II	Description	1	2	3	4	5	6	7	8	9
1	✓		Clear & Grubb									
2	✓		Common Excavation									
3	✓		S.R. Excavation									
4	✓		Demolition									
5	✓	✓	Dewater									
6		✓	Borrow									
7		✓	Re-Steel									
8		✓	C.I.P. Concrete									
9	✓		Rx. Bolts									
10		✓	Drainage Piping									
11		✓	Misc. Metals									
12		✓	Stoplogs									
13		✓	Biol. Bldg.									
14	✓		Access Bridge									
15		✓	Mechanical									
16		✓	Equipment									
17		✓	Electrical									
18		✓	Asphalt Concrete									

TABLE 2.